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Sustainable energy management in urban transport: The public's response of road congestion pricing in Thailand

Janthana Kunchornrat*, Rattanachai Pairintra, Pichai Namprakai

School of Energy and Materials, King Mongkut's University of Technology Thonburi, 126 Pracha-Uthid Rd., Bangmod, Thungkru, Bangkok 10140, Thailand

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Abstract

Fuel consumption of vehicles is one of the most vigorously debated issues in Thailand. Concerns about the effect of emissions from the vehicles and a significant reliance on imported oil provide legitimate reasons for government action to manage fuel consumption. There are several different policy measures available to affect the fuel-efficient vehicles as well as reduce the amount of driving. This paper presents the major policy measure studies namely congestion pricing, etc. In congestion pricing measure, we conducted a survey of 400 samples in Bangkok area. The purpose of the survey was to inform respondents about a policy designed to reduce freeway congestion and to estimate respondent support for this policy. After receiving extensive information about the policy, respondents were polled on whether they would support, i.e., vote for any or all of these options. The results of the congestion fee survey suggest that 22% of commuting motorists in Bangkok will support congestion fees on the freeways of the region. Public acceptance is substantially enhanced by promising to return at least some of the revenues in the form of reductions in other taxes.

Keywords: Road congestion pricing; Traffic management; Public's response survey; Fuel saving

*Corresponding author. Tel.: +66 2 4708695 8x215; fax: +66 2 4708635.
E-mail address: janthana.kun@kmutt.ac.th (J. Kunchornrat).

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1. Introduction

The transportation sector now represents about 38% of total energy consumption and 99% dependent on oil [1]. As the number of vehicles is increasing rapidly, and, moreover, due to the growth rate of motorization, the vehicle-km per population is also increasing. The accelerating expansion of the transportation will affect air quality everywhere, especially in urban areas where people live and work, and are difficult to disperse. Poor people in particular suffer, including young and the old who have limited mobility. The primary effect is on people's health, and many emitted substances also affect plants, soil and water. Carbon emissions from the transport sector pose an increasing threat of climatic change. The Global Environment Facility estimates that transport contributes 15% of all carbon emissions at present, but forecasts 50% of the increases in carbon emissions in the next 10 years [2].

Several factors affect the level of emissions from vehicles such as the type and quality of fuels that are used, emission control technologies installed during production, vehicle maintenance practices, and the age and rate of turnover of the vehicle fleet. Generally, the countries have been taken to reduce the level of vehicle emissions by focusing on incorporating emission control standards and technologies at the production stage, changing the type and quality of fuels, and improving maintenance services. Vehicle inspection programs can improve maintenance levels for vehicles and being about a higher turnover of vehicle. Less attention has been paid to transport planning, including promotion of the use of demand management techniques such as taxation, traffic management, the use of public transport and commuting driving behavior, etc. as the means of reducing energy use.

Increasing consumption of petroleum is also responsible for emissions of greenhouse gases (chiefly carbon dioxide), which contribute to global climate change. The transportation sector is the large contributor to the emissions of CO_2 in Thailand, with about 30% of the total emissions of CO_2 generated by cars and light-trucks. These emissions are projected to grow at a rate of 1.8% per annum [3]. The increase in the

consumption of oil in Thailand presents an extremely challenging energy and environment problem. Effective measures will have to be undertaken to reduce fuel consumption for reducing the risks to economy and environment.

The objective of this study is to highlight policy options available to reduce the fuel consumption of Thailand's personal vehicles. More specifically, we will argue that there are viable technology and policy options for making progress in this problem, but an integrated set of fiscal and regulatory strategies is essential to make the use of the petroleum and greenhouse gas emissions growth path. We will attempt to demonstrate that each policy, which carefully combines market-based and regulatory measures, can be used to both pull and push efficient vehicles into city, as well as to reduce the energy and carbon intensity of vehicle use. The research work was conducted based on theoretical assessment and survey results designed to estimate respondents' support for these policy options. After receiving extensive information about these policies, respondents were polled on whether they would support, i.e., vote for any or all of the options. For the time being the surveys were conducted in Bangkok Metropolitan Area.

2. Transportation issues in Thailand

In 1992, the United Nation Conference on Environment and development (UNCEP) took place in Rio de Janeiro. One of the key outcomes arising from the Rio conference was the recognition of the linkages among environment, economics and development. The Rio Conference set out a number of principles and action plans for sustainable development, which are detailed in the Agenda 21 program. These have recently been revisited at the "Rio plus 5" Conference held in 1997 in Brazil and at the Earth Summit meeting of Heads of State. While progress has been described as slow and painstaking, the principles and action programs set out in Agenda 21 continue to guide the activities of developed and developing countries in ensuring that environmental concerns are incorporated in development strategies [4].

Environmental issues in Thailand were given greater emphasis and preference during the 7th (1992–1996) and 8th (1997–2001) National Economic and Social Development Plan. The Royal Thai Government also undertook a comprehensive overview of the challenges facing Thailand, and developed a 20-year plan and prioritization of activities encapsulated in the Thailand Policy and Prospective Plan for Enhancement and Conservation of National Environmental Quality, 1997–2016 (The 20 year Policy and Prospective Plan) [5,6].

In the part of air pollution, Thailand's most significant environmental threat is that of urban air pollution, and the capital city of Bangkok stands out as the worst among urban areas in Thailand in practically every category of pollution especially that of air pollution. In 1992, the United Nations Environment Program (UNEP) reported that the Thai capital was one of the most air-polluted cities in the world due to the city's notorious traffic problems. Public exposure to poor air quality in the Bangkok Metropolitan Region (BMR) is estimated to cause thousands of premature deaths and several million cases of pollution-related sicknesses every year. In early 1990s, the costs associated with pollution-related health problems in Bangkok were estimated as 8–10% of the annual urban income. These damages to human health and the economy are expected to rise a staggering 20% by 2025. While dust lead, suspended particulates, CO and CO_2 emission are all to blame particulates smaller than 10 μm currently are considered the air pollutant of primary concern [7].

Current policy effort to clean up Thailand's air pollution problems seems promising as in February 2000, the World Bank declared Bangkok to be Asia's prototype city in air pollution management. The government and citizens of Thailand have initiated a number of programs to improve the quality of air, including a new project (funded by the World Bank) aimed at curbing the emission of thousand of motorcycles and buses in the BMR. Recently, in a further effort to reduce the level of traffic and air pollution, the city of Bangkok has built an elevated rail system—the first completed project in a series of ideas aimed at improving public transportation within the BMR. Thailand has also taken a landmark step in the country's decision to switch from leaded to unleaded gasoline. And, as a result of the country's introduction of premium unleaded gasoline, ambient lead levels in 1998 were almost 20 times lower than 1991 levels.

By implementing the Management of Air Quality in Bangkok the Bangkok Metropolitan Administration has long recognized the need for continuous reduction of air pollution in the metropolitan, in order to mitigate its impacts on public health. The improvement of air quality in Bangkok has been included by the national government in the policy on protection of public health formulated in accordance to the 8th National Economic and Social Development Plan (1997–2001). The policy recommended clear measures for management and improvement of the air quality including the increase in number of roads, traffic improvement, development of public transport systems, reduction of lead in gasoline and improvement of fuel quality. Although same measures, such as the use of unleaded gasoline nationwide in 1999, have been very successful, some measures under responsibilities of several agencies have not been effective due to the lack of harmonization, independence and sufficient coordination. In the 9th National Economic and Social Development Plan, supports were provided for continuous implementation on capacity building for environmental improvement. However, such supports were neither sufficient nor effective due to economic crisis the country was facing by that time.

As measures for reducing air pollution, the Bangkok Metropolitan Administration has declared the year 2005 as the year for mitigation of air pollution through the implementation of 13 measures [8]. The measures are as follows:

(1) Setting up check points: Check points for vehicles that emitted black smoke have been set up at 50 areas in Bangkok. Emission inspection at the checkpoints by the Bangkok Metropolitan Administration has been successful to certain level.
(2) Mobile inspection units.
(3) Motorcycle units: Motorcycle units have been assigned to 50 checkpoints to arrest the spotted violators.
(4) Pollution free road: Campaigning for cooperation from motorist, especially those without additional passengers, to avoid heavily congested route during the peak hours.
(5) Air quality reporting: Air quality from 17 air quality measuring stations has been reported to the public.
(6) Engine inspection and tune-up services: Free vehicle inspection and tune-up services have been provided at 6 services stations.
(7) Campaigning and public relation boards: Boards have been set up for urging public cooperation to avoid the 8 pollution-free roads during peak hours as well as to report air pollution information to the public.
(8) Strictly enforcing the use of covering sheets at construction sites.
(9) Strictly enforcing the use of covering sheets by trucks.

(10) Improvement of road shoulders.
(11) Inspection of white smoke from motorcycle.
(12) Car-free road.
(13) Improvement of fuel quality.

3. Energy, transport and environmental quality

Among many ways that transportation activities can affect the environment, one of the most important for developing countries is air pollution resulting from fuel combustion. In addition, construction and operation of transportation facilities can often cause major environmental disturbances. By directly affecting the composition and prices of fuels available, energy policies have a large potential role to play in environmental policy, not just with respect to transportation but with respect to other economic sectors. Energy policies can also indirectly affect other environmental consequences of transportation, since changes in demands for transportation services will affect the demand for new transportation infrastructure. It is unlikely, however, that energy policy will be a significant tool for controlling the environmental effects of transportation infrastructure projects other than air quality; hence; this paper focuses on emissions and air quality in the nexus of energy, transport, and environmental issues.

The transport sector is an important contributor of emissions in the cities of developing countries, and not just of pollutants most frequently associated with motor vehicles in wealthy countries (HC, CO, NO_x and lead). As shown in Table 1 [9], motor vehicles are also important sources of SO_2 and fine particulates, a circumstance probably Energy. Transportation and Environment: Policy Options for Environmental Improvements owing to poorer fuel quality and the greater importance of diesel and two-cycle engines in these countries.

4. Congestion pricing policy measure

In this policy measure we report on the results of the surveys conducted in Bangkok Metropolitan Area during March and April 2006. The purpose of the surveys was to

Table 1
Contribution of motor vehicles to urban air pollution

Cities	SO_2	TSP	CO	HC	NO_x
(Percent of total air emissions)					
Bangkok	39	22	NA	NA	76
Beijing	–	–	39	75	76
Bombay	5	24	–	–	52
Budapest	12	–	81	75	57
Cochin, India	–	–	70	95	77
Colombo, Sri Lanka	94	88	100	100	82
Delhi	13	37	90	85	59
Lagos, Nigeria	27	69	91	20	62
Mexico City	22	35	97	53	75
Santiago	14	11	95	69	85
Sao Paulo	64	39	94	89	92

inform respondents about a set of pricing policies designed to reduce main freeway congestion, and to estimate respondent support for the policy. After receiving extensive information about the policy, respondents were polled on whether they would support, i.e., vote for any or all of these options. The surveys were developed after extensive focus on group testing and in consultation with the survey experts. The draft questionnaire was then pre-tested.

The surveys are somewhat unusual because they elicited extensive information from the respondent on driving behavior and vehicle ownership and used this information to estimate what the respondent's annual fee obligation would be. Questionnaire data were collected into the computer and then used to calculate the fees confronting the respondent. The information on personal, family, and driving characteristics, as well as respondent's views about a number of pertinent issues, were also useful in explaining the observed voting patterns elicited by the survey. The surveys are also unusually explicit about the fate of the collected revenues, and, in particular, they include examination of policies that return a substantial portion of the revenues to the public, either in the form of pricing reductions in public transportation service or in the form of coupons to be used for vehicle emissions equipment repair, transit, and the like.

The survey samples were stratified random samples of adults (age 18 or greater) in the 6 districts. Over-sampling was necessary to ensure adequate geographical coverage. For each district, the number of completed questionnaires in the surveys (persons represented by each respondent) is shown in Table 2.

4.1. Survey samplings

The survey samples were stratified random samples of adults (age 18 or greater) in the 6 district groups, consisting of 12 subdistricts. Over-sampling was necessary to ensure adequate geographical coverage. For each district, the number of completed questionnaires in the surveys (persons represented by each respondent) is shown in Table 2. In

Table 2
Congestion fee survey samplings

District group	District	Number of population	Population proportion	Number of samplings
1. Wangloeng	Pranakon	79,293	5.07	20
	Pratumwan	98,903	6.33	26
2. Burapa	Jatujak	171,856	10.99	44
	Bangkapi	146,621	9.38	38
3. Srinakarin	Prawet	128,816	8.24	32
	Suanluang	114,626	7.33	30
4. Chaopraya	Sathon	107,797	6.90	28
	Dindang	158,314	10.13	40
5. North Krungton	Bangplud	118,000	7.55	30
	Bangkokyai	86,345	5.52	22
6. South Krungton	Thonburi	179,555	11.49	46
	Jomthong	173,097	11.07	44
Total		1,563,223		400

the congestion fee survey we screened out adults who reported that they did not travel on the freeways during rush hours. In such cases the excluded adults might be expected to be more supportive of the fee policies, as they will not be paying into the system but are likely to benefit from traveling by less-congested freeways and government spending of the revenues.

4.2. Survey description

The congestion fee survey consisted of three parts. In the first part we elicited from the respondent some fairly detailed information about the respondent's commuting behavior, including the number of rush-hour commutes per week, travel time and distance, travel mode, etc. This part of the survey generated useful information about commuting behavior, but its main purpose was to estimate the weekly and annual fees that would be paid by the respondent. The second part of the survey asked a set of standard demographic questions: age, marital status, education, family composition, work status and income. Because the personal nature of these questions often causes respondents to terminate the data analysis, this set of questions was placed at the end, after the opinion questions had been asked. The third and most important part of the survey elicited opinions on several different congestion fee policies. All respondents had been described a "base" policy, in which a fee of 20–50 baht per time (depending on current congestion level) was to be levied on all freeways in the region. Respondents were told that, based on their reported commuting behavior, the policy would cost them an estimated X baht in congestion fee each week, with the revenues to be used for a variety of transportation-related purposes. They were also given an estimate of the weekly time savings that would result from the policy. They were then asked whether they would support a referendum the policy described. A follow-up question determined whether their support or opposition was "definite" or "probable."

It was necessary to convey to the respondent a great deal of information about the congestion fees: information about the features of the basic plan, such as the transponder technology, treatment of carpools, and uses of the revenues. In order to keep the respondent engaged in the referendum process, we presented this information to respondents in the form of questions: "Suppose X. Would you be more or less likely to support the fee policy?" In addition, we wanted to remind respondents of the different ways that people might respond to the fees, such as rescheduling some of their trips or using transit. We presented this information as a series of questions structured as: "Some people say that congestion fees will cause people to do X. Do you think this will happen most of the time, some of the time, or almost never? While the main function of these questions was to convey information to the respondent, the answers are also available for analysis. We found, however, that the responses to the features of the plan are difficult to interpret. For example, most of those opposed to the base fee described themselves as "less likely" to support any given feature. Such respondents were apparently choosing the most negative category to the question and did not want the interviewer to get the impression that they might support any feature of it. The responses to the "belief" questions appear to be more meaningful, and in general we found that those who thought the congestion fees would be effective in changing behavior were more likely to support the policy. It is difficult, however, to determine which is causing what. As shown in the questionnaire, the sample was then split randomly into thirds, with each third getting a

set of questions related to a variation of the congestion fee policy. The three policy alternatives examined are as follows:

(a) *Congestion fees for public transport pricing reductions*: Respondents were told that a certain portion of the fee revenues (25%, 50% or 82%) would be used to reduce the price of public transportation service, such as public buses or sky train or underground train or boat transport. The respondents were also given an amount of the price reduction. For the purpose of the survey these price-reduction amounts were computed by taking 25%, 50% or 82% of the respondent's estimated congestion fee payments, although, of course, respondents were not informed of this.

(b) *Congestion fees for vehicle services*: Respondents were told that they would be given coupons that could be used for a variety of transportation vehicle-related services, including public or private service, vehicle emission equipment repair, etc. The face values of the offer were 25%, 50% or 82% of the respondent's estimated fee payments.

(c) *Hot lanes*: Respondents were asked if they would support a policy in which fees would be charged only on the left-most lane of all freeways. It was made clear that this would mean a reduction in the number of lanes available for "free" travel. A separate question asked whether the respondent would support fees if they were levied only on newly constructed lanes.

4.3. Results and discussion

For ease of comparison, the support and opposition to each of the policies examined are shown as the support for the base congestion fee policy is 22%, compared to 70% opposed and 8% undecided. For two of the three alternative policies the support increases substantially. Linking the fees to public transport reductions attracts the support of 45% of respondents, and the hot lane proposals were supported by 45% of respondents for existing lanes and 55% for new lanes. The proposal on average failed to attract any more support than the base policy. However, there were significant differences in the levels of support for the different amounts of fee distributed.

Table 3 gives the mean commuting distance and time without the congestion fee policy, together with what we told the average motorist would be the cost and time saved by the base congestion fee policy. As is usually the case, these variables were highly skewed, as shown by comparing the means to the percentiles given in the table.

4.4. Base survey

As shown in Table 4, a solid majority (70%) opposes the base congestion fee policy, with only 22% in favor. If we consider the intensity of preferences, we see that a much higher

Table 3
Respondent commuting distance and time

Items	Mean	Percentiles				
		5	25	50	75	95
Commuting distance (km)	32.6	0	5	15	30	75
Commuting time (min)	115.4	0	12	50	90	195
Weekly congestion fee	1200	0	0	4	12	34
Weekly minutes saved	30.5	0	8	61	140	315

Table 4
Support for base congestion fee policy

Support		Oppose		No comment
22%		70%		8%
Definite 10%	Probable 12%	Definite 21%	Probable 49%	8%

Table 5
Reasons given for opposition to the base policy

Reasons	Percent
Not fair to low-income people	15.4
Reported time savings not worth the reported cost	4.5
No reason given, respondent just does not like the idea	10.6
Spillover effects on other roads	21.3
Suspicious of management	12.1
Does not understand the program	5.3
Policy would not effectively reduce congestion	9.6
Too big a change, too sudden	7.0
Not fair to people with long commutes	3.4
Just a tax increase	1.4
This fee would be okay for me but would hurt other household members	1.3
Unaffordable in my household	1.6
Other	3.8
(Do not know/NA)	2.7
Total	100.0

fraction of the opposers are ‘‘definites,’’ suggesting that this policy enjoys soft support and faces hard opposition.

The most common reason given for opposing the base policy is that it is nothing but another tax. As shown in Table 5, fully a quarter of all respondents gave this as their reason for opposition. Another 10% felt the time savings were not worth the estimated cost, and 8% were skeptical about its ability to reduce congestion. About 12% cited unfairness to low-income people or those with long commutes.

The proportion of respondents favoring the plan does not vary much from one district to another. As shown in Table 6, residents of Jomthong are slightly more likely, and those of Sathon slightly less likely than residents in the other districts to support the base policy.

Although support for other policies is stronger, the respondent's attitude toward this base question is by far the best predictor of the response to those other policies. This point can be illustrated by the data in Table 7, a cross-tabulation of support for the base policy and the combined congestion fee/tax reduction.

The rows of Table 7 can be considered as the conditional support for the fees for public transportation fare reductions given their support or opposition to the base policy. Thus, among opponents of the base policy, 75% oppose the fees combined with public bus fare reductions. An even higher percentage of base fee supporters, 85% support fees with public bus fare reductions. The fact that 20% of base fee opponents change their vote, compared

Table 6
Support for the base policy by district (%)

District group	District	Support	Oppose	No comment
1. Wangloeng	Pranakon	15	82	3
	Pratumwan	17	77	6
2. Burapa	Jatujak	23	73	4
	Bangkapi	20	71	9
3. Srinakarin	Prawet	26	68	6
	Suanluang	24	69	7
4. Chaopraya	Sathon	14	84	2
	Dindang	22	72	6
5. North Krungton	Bangplud	21	75	4
	Bangkokyai	28	69	3
6. South Krungton	Thonburi	32	60	8
	Jomthong	34	61	5

Table 7
Importance of base policy (%)

Support base policy	Support congestion fees for public transportation		
	No	Yes	No comment
No	75	20	5
Yes	11	85	4
Do not know	26	38	36
Average support for public transportation	56	37	7

to only 11% of supporters, is the reason that support for the fees with public bus fare reductions is higher than support for the base policy.

Explaining base fee support, a large number of variables can be reasonably supposed to affect support for the base policy. To isolate the influences on support, we analyze a set of survey data with SPSS for Windows Program. The estimated dependent variable in these programs can be interpreted as the possibility that an individual with the given characteristics will support the policy. The independent variables include (i) socio-demographic variables indicating gender, age, education income and ethnic identification; (ii) respondent's commuting habits, including travel time and distance during commutes, use of transit or carpools; and (iii) personalized impacts of the congestion fee proposal on the respondent. The effects of the independent variables indicate their influence on the possibility of support.

There are some surprises in the results, especially with respect to the demographic variables. It would have been reasonable to expect, for example, that respondents with higher incomes would have supported congestion fees, because they would tend to value the time savings more. Moreover, we expected that more educated respondents would be more likely to be able to incorporate the information provided during the survey and better understand the arguments in favor of user fees, and therefore would be more likely to support the policy than those less well-educated. In the event, we found no income effect at all and education was negatively associated with support. Perhaps more educated

respondents were more skeptical of an untested economic theory or the competence of governments to implement these ambitious plans. The strongest result among the demographic variables was the very strong support for the policy among male respondents. Again, we have no explanation for this result. Among the commuting behavior variables, only the carpool and transit use variables affected support, and only weakly. Certainly individuals with more days in carpools or in transit will benefit more from congestion fees and will be more likely to support them, but we found only borderline support for this hypothesis. This result may be a consequence of the small number of transit and carpool users in the sample; average transit and carpool use was only 0.14 and 0.53 days per week. One may need a larger sample of transit users or carpoolers to be able to discern an effect.

Neither trip length nor duration nor the number of commutes per week had any effect, but we had no a priori expectation about those variables. On the one hand, more rush hours should mean more time savings from congestion fees, but on the other hand require greater congestion fee payments. Similar considerations apply to the trip distance. The variables of greatest interest are those that correspond to the individual costs and benefits of congestion pricing policy: minutes saved and estimated cost per hour saved. The cost per hour saved is calculated by taking the respondent's estimated congestion fee payments per week and dividing by the estimated time savings attributable to the fee policy, both quantities being determined by the survey program. It is simply the unit price of time savings to the individual. Indeed, we find that an increase in the unit price causes support for the policy to decline.

We also find that support declines as the "minutes saved" variable increases, a result that at first glance appears counter-intuitive and requires comment. One might think that an increase in minutes saved ought to be perceived by the respondent as a good thing and hence something he should vote for. Because the unit price is included in the regression, however, what the coefficient on the minutes-saved variable really tells us is the following:

How does the time savings affect support if the respondent's cost increases proportionately to the time savings? In effect, we are presenting the respondent with a fixed quantity of time, at a fixed price, and asking if he wants to buy. It is not at all surprising to see the level of support drop as the quantity increases. In fact, we might expect the level of support to be more sensitive to the minutes-saved variable when the quantity, and hence the payment required, is large.

In the final specification we add as a variable the respondent's view as to whether congestion pricing would cause travel to move faster. This was by far the most potent variable increasing support, although other "belief" variables also were strongly associated with the policy. This leads to the tentative conclusion that an effective campaign to educate the public on the benefits of congestion pricing may produce dividends. In addition, support may increase as word spreads about the experience with pricing experiments in other countries.

4.5. Congestion fees for public transportation development

Table 4 above suggests that respondents favor the transportation alternative by an amount of 70%, but a closer look at the subsamples of individuals presented with the public transportation alternative suggests that this percentage may be an overestimate. Although 22% of the entire sample supported the base policy, the support for it among those individuals in the public transportation support subsample is 41%. Furthermore,

46% of respondents support the base policy in the subsample where the total return revenue is 50% of the total revenues. Considering the strong influence of support for the base policy on support for the rebate policy, it is hardly a surprise that over 55% of the respondents in this group favored the return revenue. A better estimate of the support for the various levels of the rebate is obtained when we use conditional probabilities to adjust the level of support to reflect the support for the base policy in the overall sample. All estimates of the support level are used in this report. The levels of support in the three subsamples are 45%, 48%, and 43%, respectively. Since the standard errors in the proportions in these subsamples are about 3.5%, these differences are not statistically significant. However, the difference between the rebate policy and the base policy is significant. The rebates appear to enhance support for congestion fees by about 7% points.

Table 8 shows that support for the combined fee/rebate policy varies significantly from district to district. It is extremely popular in Thonburi, better than the other, and not popular at all in Sathon, with the other 10 somewhere in between. We have no hypothesis to explain these regional differences.

The level of support is higher if the net fee is less than 0 (i.e., the respondent is told they will get a larger rebate than they pay in), but otherwise it is fairly constant, as shown in Table 8 this suggests what is commonsensical, namely that it might be possible to enhance support if care is taken in the design of the rebates to minimize the number of people badly hurt by the imposition of the fees (Table 9).

As noted earlier, the best predictor of support for the rebate policy is the support for the base policy. Even after we take into account the base support variable, we find that

Table 8
District support for the congestion fees for public transportation (%)

District group	District	Support	Oppose	Do not know
1. Wangloeng	Pranakon	19	77	4
	Pratumwan	23	72	5
2. Burapa	Jatujak	27	67	6
	Bangkapi	31	66	3
3. Srinakarin	Prawet	27	65	8
	Suanluang	33	60	7
4. Chaopraya	Sathon	18	79	3
	Dindang	30	66	4
5. North Krungton	Bangplud	29	69	2
	Bangkokyai	36	61	3
6. South Krungton	Thonburi	40	56	4
	Jomthong	37	58	5

Table 9
Effect of net fee on support for rebate policy (%)

Amount of fee	Support	Oppose	No comment
Net fee <50	80	17	3
$50<$Net fee <100	47	45	8
Net fee >100	18	77	5

Table 10
Regional support for coupon policy (%)

District group	District	Support	Oppose	No comment
1. Wangloeng	Pranakon	32	65	3
	Pratumwan	28	68	4
2. Burapa	Jatujak	36	57	7
	Bangkapi	34	62	4
3. Srinakarin	Prawet	30	64	6
	Suanluang	27	65	8
4. Chaopraya	Sathon	26	69	5
	Dindang	33	63	4
5. North Krungton	Bangplud	28	65	7
	Bangkokyai	37	61	2
6. South Krungton	Thonburi	35	64	1
	Jomthong	38	60	2

respondents with negative net fees are significantly more likely to support the rebate policy. When we analyze the support on both the size of the rebate and the congestion fees, we find both to be approaching significance with correspondent. There, attention is focused on the shifters—those who changed their vote from the base to the rebate policy.

4.6. Congestion fees with coupon for vehicle services

Unlike the cash rebate policy discussed above, the use of coupons did not on average improve support for congestion fees. Support for coupons is 36%, less than that is found for the base policy in the entire sample. However, support was quite sensitive to the level of support. Support for the coupons increases substantially as the aggregate money value of the coupons increases from 25% of the fees to 82% of the fees. The remarkable regional differences in support for the cash rebates are entirely absent here, and the support for the coupons is fairly constant among the regions. In all districts, though, the support is lower than the support for the rebate policy. These results are shown in Table 10.

Analyzing the support for the coupons on their money value and on the congestion fee yields results that are strikingly similar to the rebate result. Both the coupons and the congestion fees are almost significant, with the expected results and of approximately the same magnitude.

4.7. Congestion fees on hot lanes

Respondents showed more support for congestion fees when they were told that they would apply only on the leftmost lane of the freeway. More than 45% said they would support congestion fees if an existing lane was designated a fee lane (with 48% opposed). Support increased to 54% when they were asked if they would support fees on a newly constructed lane. This was the only congestion fee policy examined which won the support of a majority of the respondents. We find another striking regional disparity in support for these hot lane policies. These policies are strongly disliked in Ventura County, even if the fast lane is to be a new one and does not decrease the number of existing free lanes. In the other four counties this policy enjoys a comfortable majority (Table 11).

Table 11
Regional support for hot lanes (%)

District on existing lanes	Support	Oppose	No comment
Pranakon	27	67	6
Pratumwan	25	71	4
Jatujak	32	63	5
Bangkapi	24	63	3
Prawet	25	67	8
Suanluang	22	76	2
Sathon	26	67	7
Dindang	19	72	9
Bangplud	20	74	6
Bangkokyai	31	66	3
Thonburi	23	70	7
Jomthong	25	73	2
On new lanes			
Pranakon	36	62	2
Pratumwan	38	59	3
Jatujak	40	54	6
Bangkapi	37	58	5
Prawet	35	62	3
On new lanes			
Suanluang	41	55	4
Sathon	42	50	8
Dindang	38	58	4
Bangplud	39	55	6
Bangkokyai	29	69	3
Thonburi	30	65	5
Jomthong	32	66	2

5. Conclusion and recommendation

The use of automobiles in personal transportation system in Thailand, steadily rising fuel consumption and resulting greenhouse gas emissions from efficient vehicles have several economic and environmental impacts. To reduce fuel consumption, significant advances in engine and vehicle technology will be available in near future. Half of the total potential of engine and vehicle technologies being developed is used to reduce fuel consumption. In reality, the market demand for such technologies is low. Technologies that can reduce CO_2 emissions (something for which consumers are reluctant to pay) could be and have been used to improve vehicle performance (something for which consumers may be willing to pay).

There exists no strong measure for reducing the fuel consumption of motor vehicles in Thailand. However, there are several different policy measures available to affect the production and purchase of more fuel-efficient vehicles as well as reduce the amount of driving and greenhouse gas intensity due to fuel use. A reinforcing combination of different policies can increase the overall effectiveness of an integrated strategy. Such an approach aims at exploiting synergies between different measures, remove perverse incentives, and increase political acceptability of the overall strategy by spreading the

impact and responsibility. An integrated set of policy actions might result in overall fuel consumption reduction. The following conclusions can be drawn from this work:

Public aversion to congestion pricing is well accepted among transportation planners and policy makers. As in most things, however, details matter. We find that the level of support for congestion pricing among survey respondents is sensitive to specific policy features designed to deal with two prominent objections to congestion pricing: the sentiment that congestion pricing is just a tax increase by another name and that high fees unfairly penalize users who, having made their household location and occupational decisions, have little choice but to continue driving. We believe that the results can be viewed as mixed but suggestive for further research. On the one hand, we did find that the promise to refund a substantial part of the revenues to the public in the form of reductions in other local taxes increased the support for congestion fees by 5–10% points.

When the rebates are made not in cash but in kind, namely in the form of coupons for subsidized, privately provided transit, the level of support is no better than the base congestion fee policy. Although this alternative was not favored by the public, proposals like it nonetheless command the support of many in transportation policy community, because such policies offer the way to attract new revenues into alternative transportation. The failure of this scheme could be due to respondents' failure to understand fully the attributes of the transit scheme. It is a fairly subtle idea, which relies on the earmarking of fee revenues to increase the supply of alternatives to single-occupancy motor vehicles, and perhaps its implications could not be conveyed in a short survey. Alternatively, perhaps respondents understood quite well the purpose of the coupon rebates, but had no faith in the responses of the private market, or did not believe the subsidization of private sectors would provide much in the way of useful alternative transportation. This is another area where further research would be helpful.

The most attractive policy to respondents was the hot lane, which would give motorists a choice between a low-quality, low cost service and a "premium" service at a higher price. Support was especially high for newly constructed lanes. It is not accidental that the greatest increment in support over the base policy occurs for a policy that involves new construction and does not in anyway reduce the open-access resources available. This outcome is consistent with the continuing political opposition to congestion pricing, as well as the recent successes in gaining acceptance of new hot lane proposals. However, it is still only the first step. For congestion pricing to make a serious contribution, its use will have to spread to existing roads. That is not likely to happen without a better understanding of how to design congestion pricing policies and package them with transport investment and revenue recycling policies.

The survey results clearly indicate that congestion pricing on freeways on motor vehicles in Bangkok can attract levels of public support that are at least within striking distance of a simple majority. We have found that this support can be significantly enhanced by returning at least some of the revenues in the form of rebates. Offering larger rebates and lower pollution fees can further enhance support. For congestion fees we have also found support to be enhanced for policies that put fees on only some freeway lanes, especially if the tolled lanes are new and do not reduce the number of existing free lanes. The results also indicate where (both geographically and demographically) support and opposition to these plans may be found to aid in targeting publicity and informational campaigns.

There are several "public support" issues that remain to be explored in furthering the design of viable congestion plans. First, we do not know whether support is more sensitive

to the percentage of revenues returned to the people or to the actual amount returned to the individual. Second, we do not know why those with less schooling appear to favor the plans disproportionately. Third, we do not have confidence that individuals voting on the coupon and rebate plans fully understood that in that alternative less money would be available for public investments in transportation or pollution control. Fourth, more study is needed on voting patterns for those who do most of their driving outside of rush hours. The survey provided only limited information on driving patterns.

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